REMARKS

Sections A and B respond to the Examiner's objections to the declaration and the specification. Section C summarizes the status of the claims. Sections D and E respond to the rejections of the Feb. 6 Office Action.

A. Defective Declaration

The declaration filed with the present application did not provide mailing addresses or city, state, and country of each inventor. The present application is a divisional application. In the parent application, this declaration was filed with an application data sheet which provided this information. A copy of the declaration filed with the parent application was filed in the present divisional application. Through Applicants' error, however, no application data sheet was provided in the present application.

Examiner directed Applicants to provide a replacement declaration or an application data sheet. Applicants have provided an application data sheet with the required information for the inventors. Applicants appreciate the Examiner's identification of this error.

B. Specification Objections

The Examiner objected that the incorporation by reference of applications 09/927648 and 10/326470 in paragraph [0048] and of application 10/036291 in paragraph [0051] failed to recite that the applications are commonly assigned. The incorporated applications in fact are commonly assigned, and Applicants have amended the specification accordingly.

C. Status of the Claims

Claims 1-16 are pending in the application. Claims 1-16 were rejected under 35 USC 103(b) as being unpatentable over Mitani et al., US Patent No. 5,864,161. Claims 1-16 were rejected under 35 USC 103(a) as being unpatentable over Freeman et al., US Patent No. 5,096,856 in view of Mitani et al.

D. 35 USC 103(b) Rejections, Mitani et al.: Claims 1-16

Claims 1-16 were rejected under 35 USC 103(b) as being unpatentable over Mitani et al.

Claim 1 recites a method for depositing a doped polysilicon film comprising: providing a surface; and substantially simultaneously flowing SiH_4 and BCl_3 over the surface at a temperature less than or equal to about 500 degrees Celsius under conditions that achieve an average concentration in the doped polysilicon film of between about 7×10^{20} and about 3×10^{21} boron atoms per cubic centimeter.

The Examiner finds these elements in Mitani et al., except that the reference fails to teach the doping concentration of the claim. The Examiner continues:

> It is noted that the reference clearly teaches a boron concentration of $1x10^{19}$ to $1x10^{22}$ atoms/cm which overlaps the claimed range. Overlapping ranges are *prima facie* evidence of obviousness. It would have been obvious to one having ordinary skill in the art to have selected the portion of Mitani's range of concentration that corresponds to the claimed range.

Applicants respectfully point out, however, that several elements of the claim are missing from the teachings of Mitani et al. Claim 1 (along with the other independent claims 6 and 12) includes the limitations that the film is *polysilicon* and that it is deposited at a temperature *less than or equal to* about 500 degrees C.

Silicon is deposited when an appropriate source gas such as SiH_4 is flowed over a surface, typically at temperatures between about 540 and about 625 degrees C. As

temperature drops, the rate of silicon deposition decreases and the quality of the silicon film degrades.

In general, when a layer of silicon is deposited at a temperature of 500 degrees C or less, it will be amorphous, without crystalline structure, rather than polycrystalline. If polycrystalline silicon (polysilicon) is desired, generally the amorphous silicon layer must be annealed to crystallize the silicon, for example by a thermal anneal at a temperature exceeding 550 degrees C. An object of the present invention is to form a *polycrystalline* silicon layer without exceeding 500 degrees C. Reducing temperature will be advantageous for some uses. For example, aluminum metallization will soften and extrude when exposed to a temperature of 550 degrees, the temperature required to crystallize silicon formed by conventional means. A low-temperature method to form polysilicon allows polysilicon to be formed *after* aluminum metallization without damaging the aluminum metallization.

As is well known, p- and n-type dopants are added to silicon to enhance the conductivity of the silicon. The dopant level of the silicon is generally selected based on device requirements; i.e. on what degree of conductivity the doped silicon is to have.

In the present invention, it has been found that by flowing SiH_4 and BCl_3 at concentrations sufficient to dope the deposited film to a dopant concentration between about 7×10^{20} and about 3×10^{21} boron atoms per cubic centimeter, it is possible to deposit a polysilicon (not amorphous) film without exceeding 500 degrees C. Note that this film is polycrystalline ***as deposited***; no subsequent anneal is required.

Applicants cannot identify an embodiment of Mitani et al. in which a *polycrystalline* silicon film is deposited at a temperature at or below 500 degrees C.

The Examiner suggests that it would be obvious to select the dopant range of the claim. Applicants will respectfully suggest, however, that it is conventional to select dopant concentration based on the desired dopant concentration in the finished device, but is not conventional or obvious to select dopant concentration based on the way that dopant concentration affects deposition rate, film quality, and crystallinity at a given deposition temperature. There is no teaching in Mitani et al. describing this relationship or suggesting such a choice. It is not conventional to form a doped polysilicon film below 500 degrees, and one skilled in the art would have no motivation to select the claimed range in order to do so.

Applicants have shown that Mitani et al. fails to teach a polycrystalline film deposited at 500 degrees C or less, and have shown that one skilled in the art would have no motivation to select the dopant range of the claim. The reference fails to teach each and every element of the claim; thus Applicants respectfully request withdrawal of the 35 USC 103(b) rejection of claims 1-16.

E. 35 USC 103(a) Rejections, Freeman et al. and Mitani et al.: Claims 1-16

Claims 1-16 were rejected under 35 USC 103(a) as being unpatentable over Freeman et al. in view of Mitani et al.

Claim 1 recites a method for depositing a doped polysilicon film comprising: providing a surface; and substantially simultaneously flowing SiH_4 and BCl_3 over the surface at a temperature less than or equal to about 500 degrees Celsius under conditions that achieve an average concentration in the doped polysilicon film of between about 7 x 10^{20} and about 3 x 10^{21} boron atoms per cubic centimeter.

The Examiner finds that Freeman fails to teach the claimed dopant concentration, temperature, or pressure. The Examiner finds, however:

> It is noted that the reference clearly teaches that flow rates, temperature and pressure affect the buildup of phosphorus ... Given such a teaching, one skilled in the art would realize that temperature, pressure, and flow rates would affect the phosphorus concentration. Hence, it would have been obvious to the skilled artisan to optimize the appropriate deposition parameters including temperature, pressure, and flow rates with the expectation of obtaining the claimed doping concentration.

As described in Section D, an object of the present invention is to form a polycrystalline film without exceeding about 500 degrees C. Freeman teaches a polycrystalline film deposited at higher temperature (col. 2, lines 60-63; col. 3, lines 40-41), but does not teach or suggest how such a film could be formed at 500 degrees C or less.

The Examiner also notes that Freeman fails to teach boron trichloride (BCl_3), and suggests that, because boron and phosphorus are both known dopants, and that BCl_3 is a known precursor gas to provide boron, it would have been obvious to substitute a boron dopant for the phosphorus used by Freeman.

In the present invention it has been found that simultaneously flowing BCl_3 and SiH_4 in concentrations sufficient to dope to the claimed range promotes crystallization and increases the deposition rate, allowing deposition of polysilicon at 500 degrees C or less. There is no teaching in either Freeman or Mitani et al. that phosphorus in high concentration will tend to promote crystallization of silicon and improve deposition rate, nor any reason to believe that this would occur. Thus one skilled in the art would have no motivation to replace the phosphorus of Freeman with the boron of Mitani et al.

Applicants have shown that the proposed combination fails to teach each and every element of the claims, and that one skilled in the art would have no motivation to

make the suggested combination, and thus respectfully request withdrawal of the 35 USC 103(a) rejection of claims 1-16.

CONCLUSION

In view of the preceding Remarks, Applicants submit that this application is in condition for allowance. Reconsideration is respectfully requested. If objections remain, Applicants **respectfully request an interview.** In the event that objections remain, the Examiner is asked to contact the undersigned agent at (408) 869-2921.

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Date

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